INDOOR AIR QUALITY ASSESSMENT

Chicopee Public Safety Building
Emergency Operations Center/Board of Health Offices
15 Court Street
Chicopee, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
November 2002

Background/Introduction

In response to a request from Louise Hebert, Chicopee Health Department, an indoor air quality assessment was done at the Chicopee Public Safety Building, Emergency Operations/Board of Health Office, 15 Court Street, Chicopee, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA). Complaints from employees of headaches, fatigue, respiratory concerns and poor indoor air quality conditions prompted the request.

A visit was made to the building by Michael Feeney, Director of Emergency Response/Indoor Air Quality (ER/IAQ) on June 6, 2002. Mr. Feeney was accompanied by Ms. Hebert during the visit. The Chicopee Public Safety Complex (CPSC) is a multi-story building that is divided into three sections: the Fire Station, Police Station and Emergency Operations Center/Board of Health Offices (EOC/BOH). Since each section has separate functions and separate heating, ventilating and air conditioning (HVAC) systems, a separate report was prepared describing indoor air quality of the fire and police stations. The subject of this report is the indoor air quality of the EOC/BOH.

The CPSC was constructed in 1976. The EOC/BOH is located on the ground floor of a two-story structure in the center of the CPSC, with the fire station on its north wall and the police station on its south wall (see Figure 1). The roof of the EOC/BOH also serves as a patio (see Picture 1). No openable windows exist in this part of the building.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. No carbon monoxide readings were measured above background levels

Results

EOC/BOH offices have a population of approximately 10-15 employees on a daily basis. The tests were taken under normal operating conditions. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were below 800 parts per million parts of air [ppm] in all areas sampled. These carbon dioxide levels indicate that an adequate fresh air supply exists.

Ventilation is provided by a heating, ventilation and air-conditioning (HVAC) system. An air handling unit (AHU) manufactured by the Trane® Company (Trane AHU) provides fresh air for all areas within the EOC/BOH. The AHU draws air from the rear of the building through a large air grate (see Picture 2) via ducts. Air is then supplied to EOC/BOH offices by ceiling mounted fresh air diffusers connected to the AHU via ductwork.

Return ventilation is provided by the AHU, which draws air through ceiling-mounted exhaust grilles via ducts. The exhaust for the AHU exits the building through a vent at the rear of the building adjacent to the fresh air intake (see Picture 2). Draw of air by return vents was drawing weakly. Without proper exhaust ventilation, normally occurring environmental pollutants can build up and lead to indoor air quality complaints.

In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that HVAC systems be re-balanced every five years (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997, BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix I.

Temperature readings ranged from 69° to 75° F, which were very close to the BEHA recommended guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70° to 78° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

Relative humidity measured in the building was below the BEHA recommended comfort range in all areas sampled. Relative humidity measurements ranged from 14 to 27 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial Growth/Moisture Concern

The AHU has two compartments with separate fresh air intakes. The upper compartment contains the heating/cooling coil. The lower cabinet contains the chiller that is activated during hot weather. Both cabinets contain drip pans to drain accumulated condensation from the coils and cold surfaces of the chiller. The purpose of the lower fresh air intake vent on the exterior of the building was to provide cooling for the Trane units' chiller compressor located in the base of the AHU (see Figure 2). The drip pans within the chamber containing the air conditioning equipment were heavily coated with debris (see Picture 3). This debris, with the addition of condensation, would be expected to be a ready mold growth medium. While mold growth was not apparent, the operation of this system could result in mold growth in the chamber when the HVAC system is switched to its cooling cycle during summer months.

The accumulation of debris within the chiller cavity is directly related to the lack of filtration of outdoor air. The close proximity of the exhaust vent to the general ventilation fresh air intake of the AHU can create conditions where exhaust air may be entrained. Under the current Massachusetts building code, fresh air intakes must be *located at least 2 feet below and 10 feet away from exhaust vents* (SBBRS, 1997; BOCA, 1993). In the present configuration, minimally filtered outdoor air that may contain mold spores can be drawn into and ejected from the chiller chamber, subsequently being entrained by the AHU's general fresh air intake.

Water damage to ceiling tiles was observed directly below the patio in the Weights & Measures storeroom. Cement and brick of the patio was damaged or missing.

Plants were also found growing between slabs and brick (see Picture 4). The EOC/BOH was assessed during a rainstorm. Pooling water was observed in the patio, despite the presence of a drain (see Picture 5). Cracks on brick and cement as well as plant colonization can serve as means for water to penetrate into the Weights & Measures storeroom.

The radio room had a substantial number of water damaged/mold colonized acoustical tiles and damaged plywood (see Pictures 6 and 7). The water source that moistened the acoustical tiles appears to be utility holes that have since been sealed (see Picture 8). The acoustic tiles are glued directly to the plywood ceiling. Replacement of these ceiling tiles is difficult, since their removal appears to necessitate the destruction of the tile, which can result in the aerosolization of particulates. Ceiling tiles, acoustical tiles and plywood are porous materials that can serve as mold growth media if moistened repeatedly.

A bucket of standing water was found in the AHU room (see Picture 9). The source of water in the bucket is condensation from the AHU. Standing water can be a source of microbial growth and associated odors, which can be problematic since the condensation drain is depressurized (drawing air). If microbial growth exists, odors and associated particulates can be drawn back into the AHU and distributed into the EOC/BOH.

A floor drain exists in the AHU room, presumably to drain condensation. The AHUs provides air-conditioning during warm months. AHUs that provide air-conditioning require the installation of condensation drains to prevent water build up inside the casing and ductwork. The condensation drain for these units terminates near the floor drain that is connected to the building drainage system (see Picture 9). Drains are usually designed with traps in order to prevent sewer odors/gases from penetrating into occupied spaces. When water enters a drain, the trap fills and forms a watertight seal. Without a periodic input of water (e.g., every other day), traps can dry, preventing a watertight seal. During the heating season, the AHU does not produce condensation, resulting in the traps of the condensation drains drying out. The AHU was found to be drawing air into each unit through the condensation drain. With the condensation drain acting as a vacuum, odors from the floor drain without a water-sealed trap can be drawn into the AHU and distributed to occupied areas in the EOC/BOH.

Other Concerns

Several other conditions, which can affect indoor air quality were noted during the assessment. AHUs are normally equipped with filters that strain particulates from airflow. Filters installed in the fresh air intake of the AHU provide minimal filtration (5 % dust spot efficiency at best). In each case, minimally filtered or totally unfiltered air is introduced into the air stream of the ventilation system. In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency can be installed in the AHU. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent would be sufficient to reduce airborne particulates (Thornburg, D., 2000; MEHRC, 1997; ASHRAE, 1992). Note that increased filtration can reduce airflow produced by AHUs due to increased resistance (called pressure drop). Prior to any increase of filtration, all AHUs should be evaluated by a ventilation engineer to ascertain whether they can maintain function with more efficient filters.

The fresh air intake for the AHU is covered with a fine mesh screen to serve as a bird screen, which rapidly accumulates outdoor particles (see Picture 10). This accumulation can serve as a source of microbial growth as well as prevent airflow into the AHU.

In some areas the louvers were coated with bird waste. Each louver of the fresh air intake is supported by a metal triangle large enough to fit a bird the size of a sparrow. Bird wastes were observed inside exhaust vents along the west exterior wall of the building (see Picture 11). Under these conditions, it is possible for molds and allergenic materials associated with bird wastes and feathers to be entrained by the air intake. Bird wastes in a building raise concerns over diseases that may be caused by exposure to bird wastes. The need for clean up of bird waste and appropriate disinfection is imperative.

Certain molds are associated with bird waste and are of concern for immune-compromised individuals. Other diseases of the respiratory tract may also result from chronic exposure to bird waste. Exposure to bird wastes are thought to be associated with the development of hypersensitivity pneumonitis in some individuals. Psittacosis (bird fancier's disease) is another condition closely associated with exposure to bird wastes in either the occupational or bird raising setting. While immune-compromised individuals have an increased risk of health impacts following exposure to the materials in bird wastes, these impacts may also occur in healthy individuals exposed to these materials.

The methods to be employed in clean up of a bird waste problem depend on the amount of waste and the types of materials contaminated. The MDPH has been involved in several indoor air investigations where bird waste has accumulated within ventilation ductwork (MDPH, 1999). Accumulation of bird wastes has required clean up of such buildings by a professional cleaning contractor. In less severe cases, the cleaning of the contaminated material with a solution of sodium hypochlorite has been an effective disinfectant (CDC, 1998). Disinfection of non-porous materials can be readily accomplished with this material. Porous materials contaminated with bird waste should be examined by a professional restoration contractor to determine if the material is salvageable. Where a porous material has been colonized with mold, it is recommended that the material be discarded (ACGIH, 1989).

The protection of both the cleaner and other occupants present in the building must be considered as part of the overall remedial plan. Where cleaning solutions are to be used, the "cleaner" is required to be trained in the use of personal protective methods and equipment (to prevent either the spread of disease from the bird wastes and/or exposure to cleaning chemicals). In addition, the method used to clean up bird waste may result in the aerosolization of particulates that can spread to occupied areas via openings (doors, etc.) or by the ventilation system. Methods to prevent the spread of bird waste particulates to occupied areas or into ventilation ducts must be employed. In these instances, the result can be similar to the spread of renovation-generated dusts and odors in occupied areas. To prevent this, the cleaner should employ the methods listed in the SMACNA Guidelines for Containment of Renovation in Occupied Buildings (SMACNA, 1995).

Building occupants report periodic odors of fuel exhaust in the EOC/BOH. A room next to the AHU room contains an emergency generator (see Picture 12 and 12A). The exhaust vent for the generator terminates outside above the vents for the AHU (see Picture 2). Under certain wind conditions, it is possible that exhaust from the generator can be entrained by the AHU. Combusted fuel can produce both carbon monoxide and nitrogen dioxide, both of which can be dangerous to health in an indoor environment.

Portable electricity generators are stored within the EOC/BOH. These devices have fuel tanks. Fuel (e.g., gasoline) is a mixture that contains VOCs that can acutely be irritating to the eyes, nose and throat. Residual amounts of gasoline can off-gas from this type of equipment, which can result in VOCs being introduced into the building. Gasoline containing vehicles and equipment should be stored outside or in an area with continuous local exhaust ventilation to prevent the build-up of flammable vapors indoors.

Conclusions/Recommendations

In view of these findings at the time of the visit, the following recommendations are made:

1. The drip pans in the AHU should be disinfected and cleaned. Thoroughly disinfect and clean other water accumulation surfaces within the AHU.
2. Remove containers filled with water from the AHU room.
3. Ensure water is poured into the AHU floor drains every other day to maintain the integrity of the traps.
4. Seal the condensation drain for AHU during the heating season. Please note that the drain must be unsealed during the air-conditioning season in odor to drain condensation. ***Failure to remove condensation drain seals can result in water back up into the AHU and produce mold growth.***
5. Ventilation industrial standards recommend that mechanical ventilation systems be balanced every five years (SMACNA, 1994). Consult a ventilation engineer concerning re-balancing of the ventilation systems.
6. Examine the feasibility of increasing HVAC filter efficiency. Ensure that filters are of a proper size and installed in a manner to eliminate particle bypass of the filter. Note that prior to any increase of filtration, each unit should be evaluated by a ventilation engineer as to whether they can maintain function with more efficient filters.
7. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
8. Replace water damaged ceiling tiles (for more information see **long-term measures** below).

9. Consideration should be give to extending the emergency generator exhaust vent above the level of the patio to prevent exhaust entrainment by the AHU.

10. Implement the corrective actions recommended concerning remediation of bird wastes.

11. Examine the feasibility of taking measures to prevent bird roosting in louvers.

The following **long-term measures** should be considered:

1. Water-damaged ceiling tiles should be replaced. These ceiling tiles can be a source of microbial growth and should be removed. Source of water leaks (e.g., window frames and roof) should be identified and repaired. Examine the non-porous surface beneath the removed ceiling tiles and disinfect with an appropriate antimicrobial.

2. Replace the bird screen in the fresh air intakes to a wider gauge to prevent debris accumulation.

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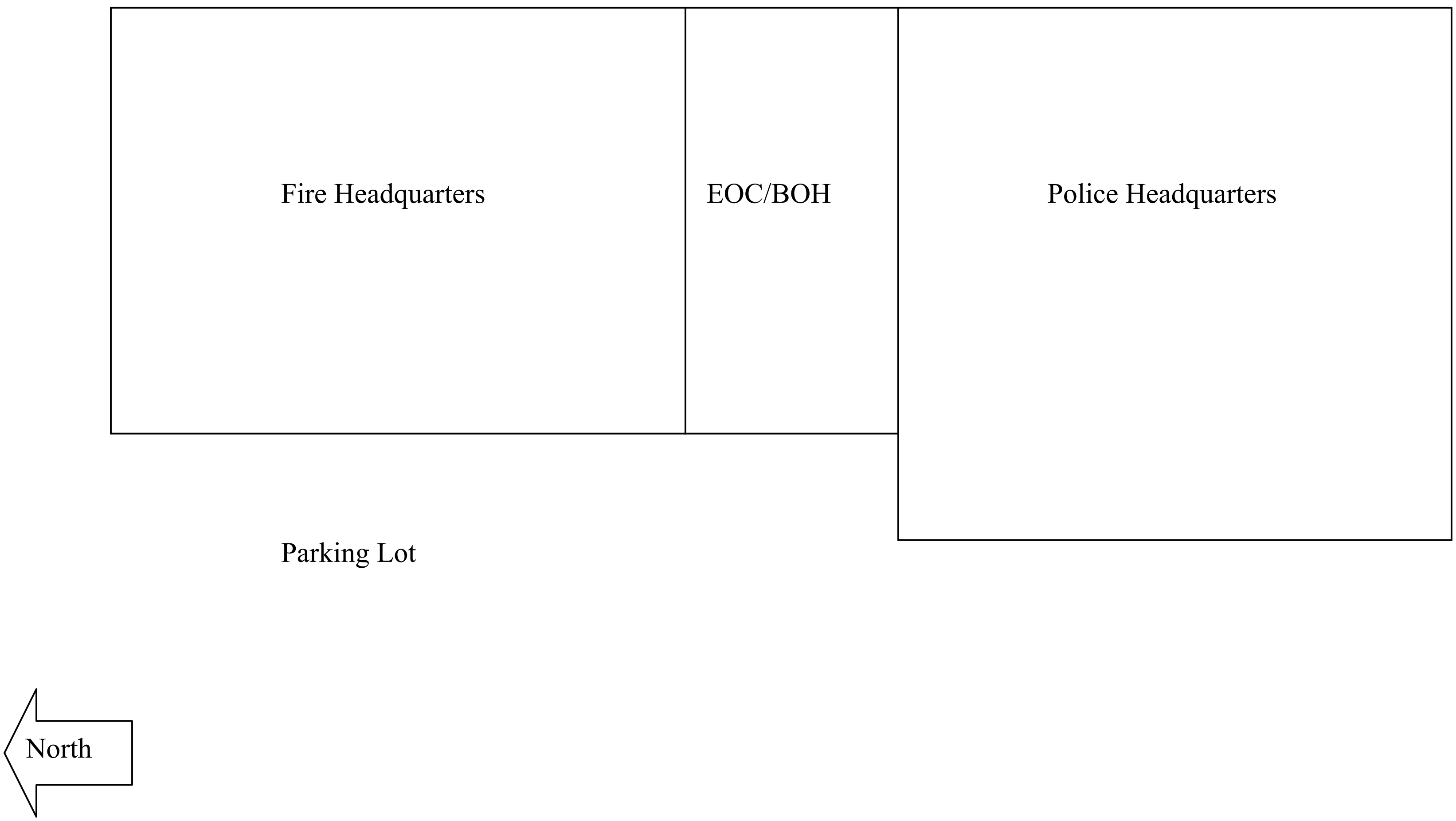
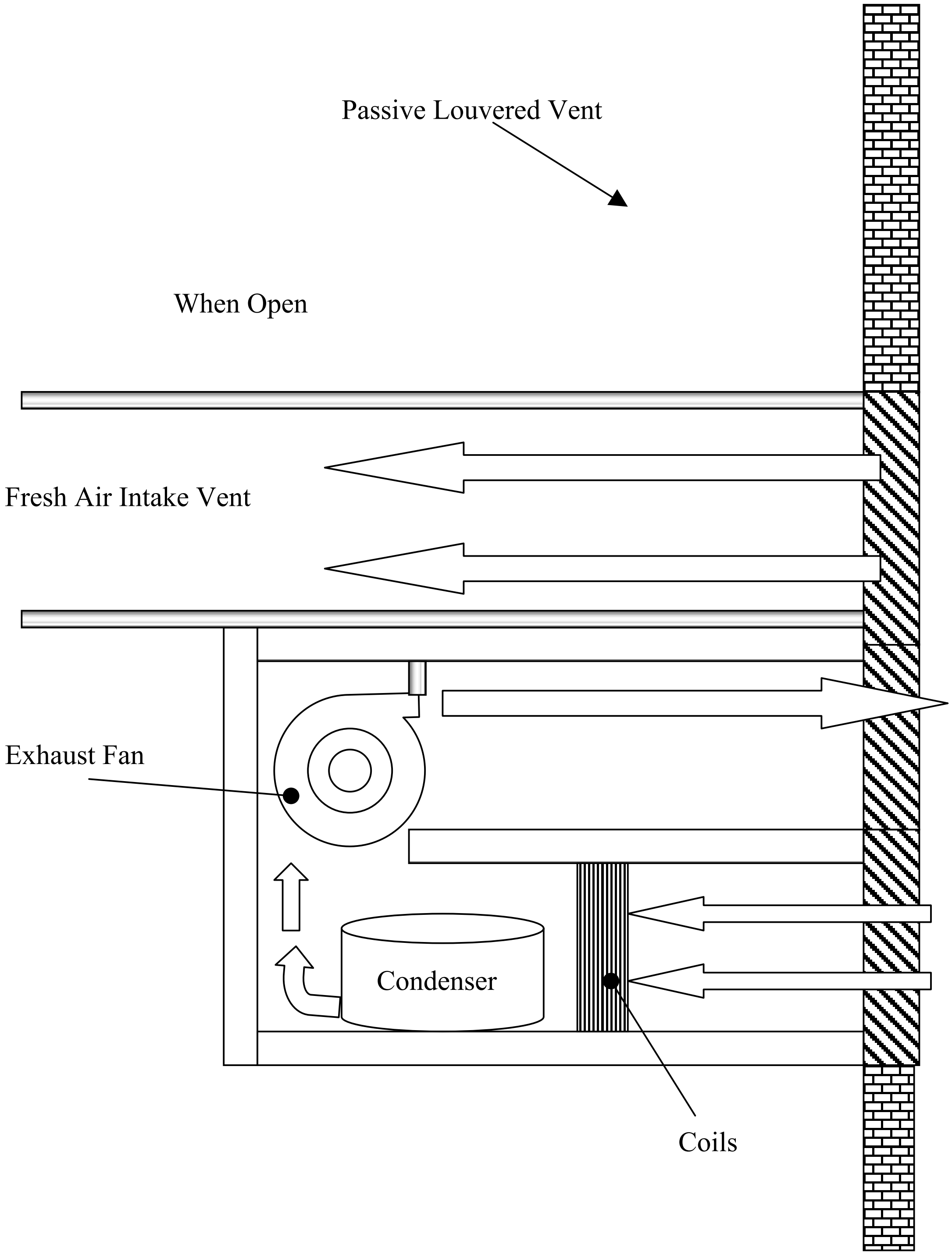
Figure 1
Configuration of Chicopee Public Safety Building



Drawing Note to Scale

Figure 2 **Configuration of the AHU Closet and Trane AHUs**



Picture 1

Patio That Serves as Roof Of EOC/BOH

Picture 2

AHU Fresh Air Intake and Exhaust Vent, Note Location Of Emergency Generator Exhaust Pipes and Vehicles to Fresh Air Intake

Picture 3

Debris in AHU Drip Pan

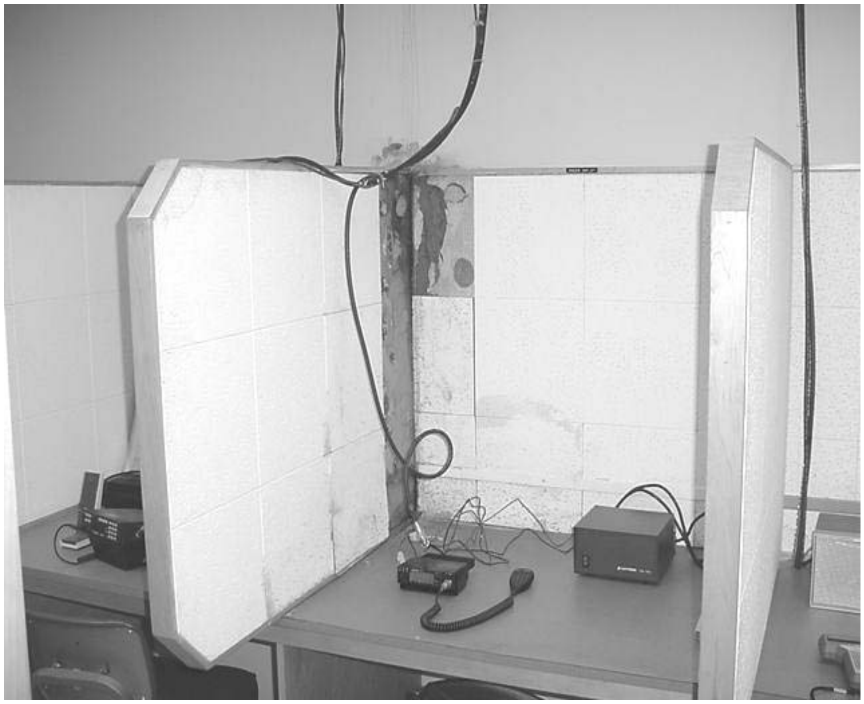
Picture 4

Damaged/Missing Caulking in Patio Cement, Brick

Picture 5

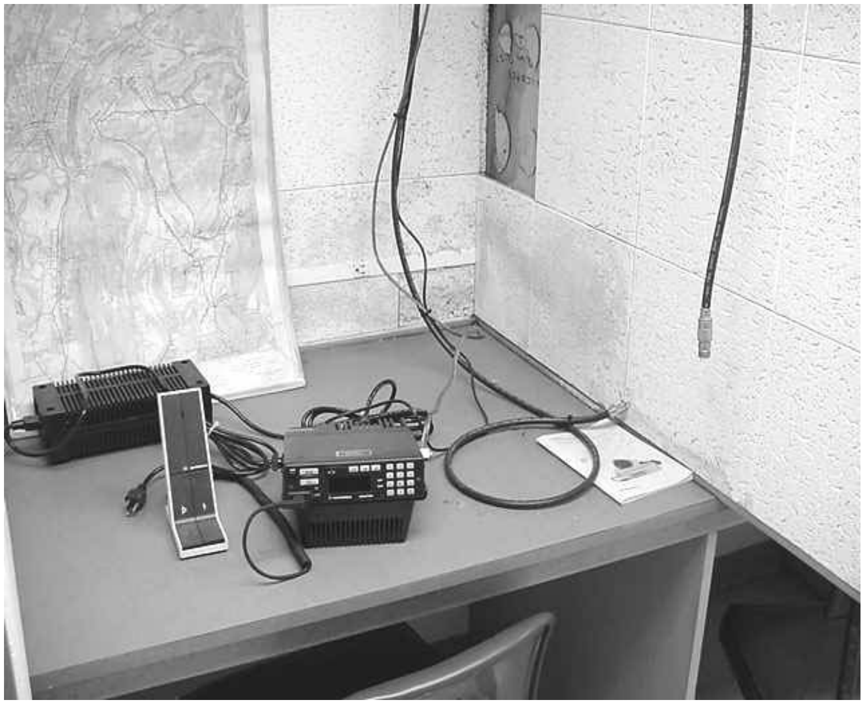
Standing Water on Patio

Picture 6



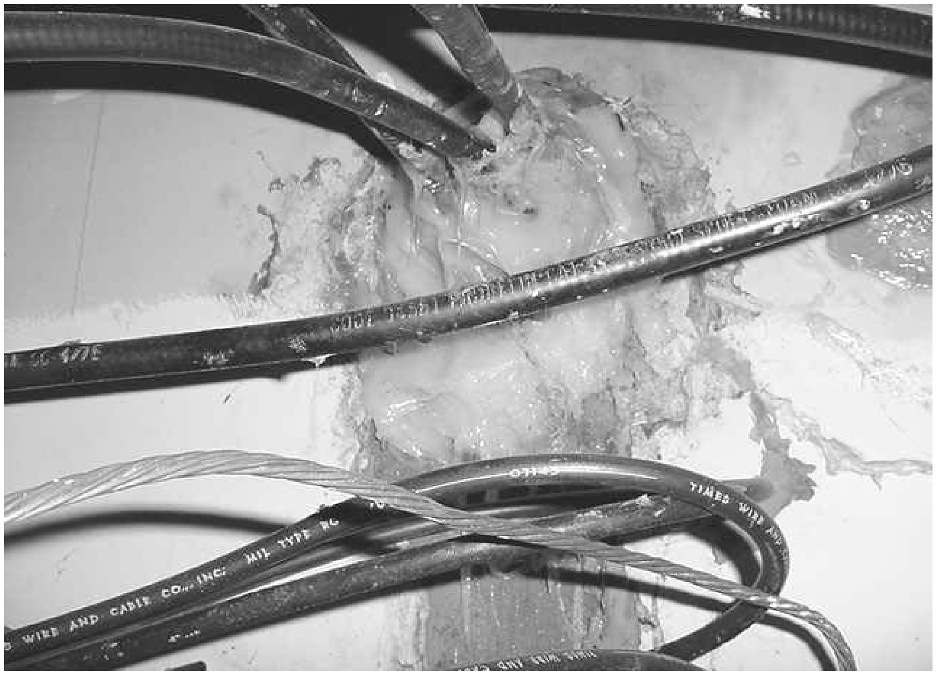
Water Damaged Acoustic Tile

Picture 7



Water Damaged Acoustic Tile

Picture 8



Sealed Pipes above Water Damage

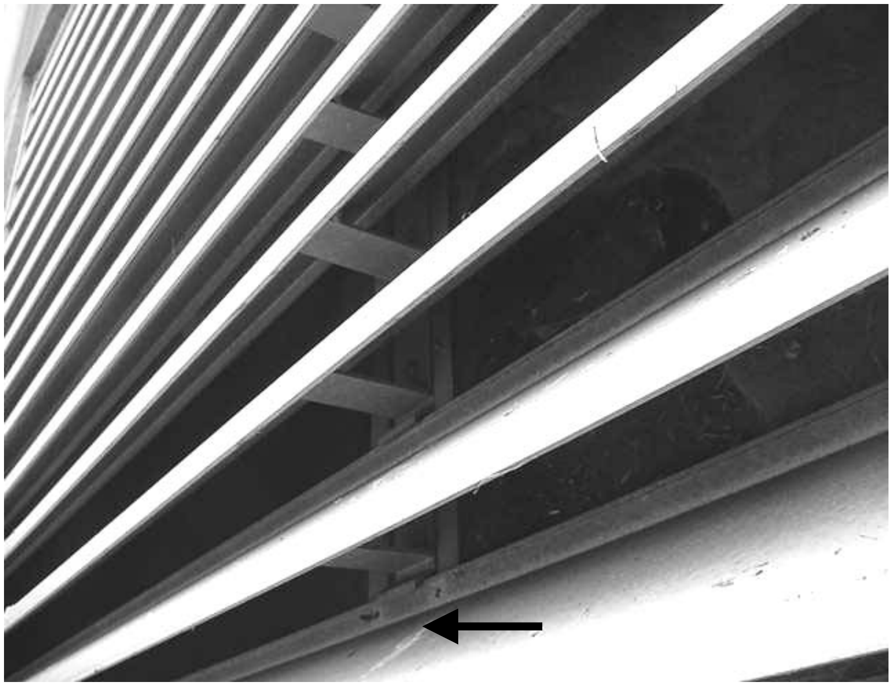
Picture 9

Bucket Collecting Condensation, Note Standing Water and Location Of Drain

Picture 10

Fresh Air Intake Bird Screen Covered in Accumulated Materials

Picture 11



Bird Waste on HVAC System Louvers

Picture 12

Emergency Generator Room Next to AHU Room

Picture 12A

Close-Up of Emergency Generator Make Air Vent and Exhaust Pipes

TABLE 1

Indoor Air Test Results – Chicopee Public Safety Building, 15 Court Street. June 6, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Carbon Monoxide *ppm	Occupants in Room	Windows Openable	Ventilation		Remarks
							Intake	Exhaust	
Outside (Background)	420	64	61	0					
Main Office	544	75	58	0	2	N	Y	Y	Exhaust minimal, exterior door open
Weights & Measures	527	72	60	0	1	N	Y	Y	Exhaust minimal, door open
W & M Storeroom	446	71	60	0	0	N	Y	Y	Exhaust minimal, door open, CT-7
Public Health Nurse	531	72	59	0	1	N	Y	Y	Exhaust minimal, door open
Code Enforcement	460	72	59	0	0	N	Y	Y	Exhaust minimal, door open
Board of Health	522	72	58	0	2	N	Y	Y	Exhaust minimal, door open, door open
Radio Room	466	72	59	0	0	N	Y	Y	Exhaust minimal, WD acoustical tiles-18, 2 emergency generators
Radio Room Storage	461	72	58	0	0	N	Y	Y	Exhaust minimal, CT-2
Director's Office	525	72	58	0	1	N	Y	Y	Exhaust minimal, door open

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Chicopee Public Safety Building, 15 Court Street. June 6, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Carbon Monoxide *ppm	Occupants in Room	Windows Openable	Ventilation		Remarks
							Intake	Exhaust	
Break Room	481	72	58	0	0	N	Y	Y	Exhaust minimal, 2 refrigerators, door open
Kitchen	447	69	65	0	0	N	Y	Y	Exhaust minimal
Main Office Rear	457	71	61	0	2	N	Y	Y	Exhaust minimal

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